Serum vitamin and microelement nutrition of children with pneumonia and their relationship with the inflammatory state and immune response

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Objective: To analyze the serum vitamin and microelement nutrition of children with pneumonia and explore their relationship with the inflammatory state and immune response.

Methods: A total of 78 children with pneumonia who were treated between May 2014 and May 2016 were collected as the observation group, and 50 health children who received vaccination in our hospital during the same period were collected as the normal control group. High performance liquid chromatography was used to determine serum vitamin A (VitA) content, atomic absorption spectrometry was used to determine serum Fe content, and the median VitA and Fe contents were used to further divide the observation group into high VitA group and low VitA group as well as high Fe group and low Fe group, 39 cases in each group. The inflammatory and immune response state in pneumonia children with different VitA and Fe contents were determined. Results: Serum VitA and Fe contents of observation group were lower than those of normal control group; serum inflammatory cytokines IL-6, PCT, sTREM-1 and CRP contents as well as humoral immunity indexes IgG, IgA and IgM contents of low VitA group and high VitA group were higher than those of normal control group, and as serum VitA content reduced, the inflammatory and immune response were enhanced; serum inflammatory cytokines IL-6, PCT, sTREM-1 and CRP contents as well as humoral immunity indexes IgG, IgA and IgM contents of low Fe group and high Fe group were higher than those of normal control group, and as serum Fe content reduced, the inflammatory and immune response were enhanced. Conclusion: Serum VitA and Fe contents were low in children with pneumonia, and their contents are negatively correlated with the inflammatory state and humoral immune response degree.

1. Introduction

Pneumonia is the disease with the highest incidence in childhood, both disease protraction and repeated attacks can lead to limited growth and development of children, and severe cases may develop important organ complications[1,2]. Vitamin A (VitA) is the necessary vitamin for the body, it influences children's nutrition supply while controls immune function, and many studies have shown that VitA deficiency might increase the occurrence of respiratory system and digestive system diseases in children[3]. Iron (Fe) is a necessary microelement for the children's growth and development, and directly involved in the body's immune response, and Fe deficiency will cause the lymphocyte DNA synthesis disorder[4]. In the following study, the serum vitamin and microelement nutrition of children with pneumonia and their relationship with the inflammatory state and immune response were analyzed.

2. Information and methods

2.1 Case information

A total of 78 children with pneumonia who were treated between May 2014 and May 2016 were collected as the observation group,
and they were diagnosed after abdominal CT and hematology indexes; 50 health children who received vaccination in our hospital during the same period were collected as the normal control group, and the included children’s families signed informed consent. Observation group included 40 male cases and 38 female cases, they were 1-9 years old, the birth weight was 2.84-4.12 kg, and the course of pneumonia was 3-7 d; normal control group included 27 male cases and 23 female cases, they were 1-8 years old, the birth weight was 2.79-4.21 kg, and the course of pneumonia was 2-7 d. Two groups of children were not statistically different in gender, birth weight and course distribution ($P$>0.05). Hospital ethics committee members discussed and approved the study.

2.2 Observation indexes

Immediately after inclusion, 1.5 mL peripheral venous blood was extracted from two groups of children, anti-coagulated with sodium citrate and centrifuged at low speed to get supernatant and freeze it in the cryogenic refrigerator for test. Specific detection indexes were as follows: (1) serum vitamin A and microelement Fe: high performance liquid chromatography was used to determine serum vitamin A (VitA) content, and serum Fe content was detected by atomic absorption spectrometry. (2) Inflammatory factor: enzyme-linked immunosorbent assay (ELISA) was used to determine serum inflammatory factor, including interleukin-6 (IL-6), procalcitonin (PCT), soluble triggering receptor expressed on myeloid cells-1 (sTREM-1) and C-reactive protein (CRP). (3) Humoral immunity: scattering method was used to determine serum immunoglobulin G (IgG), immunoglobulin A (IgA) and immunoglobulin M (IgM) contents.

2.3 Statistical methods

Personnel (1-2) with professional statistical knowledge were selected to record and calculate the data obtained in the study, measurement data was in terms of ($\bar{x}$±s), comparison between groups was by grouping t test and $P$<0.05 was set as the standard of statistical significance in differences.

3. Results

3.1 Serum vitamin A and microelement Fe

Comparison of serum VitA and Fe contents between two groups of children was as follows: serum VitA and Fe contents of observation group were significantly lower than those of normal control group, and differences between groups were statistically significant ($P$<0.05), shown in Table 1. The median of serum VitA content of observation group was 0.94 μmol/L and used as boundary to divide the observation group into high VitA group and low VitA group, 39 cases in each group; the median of serum Fe content of observation group was 17.28 μmol/L and used as boundary to divide the observation group into high Fe group and low Fe group, 39 cases in each group.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>VitA</th>
<th>Fe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>78</td>
<td>0.89±0.09</td>
<td>15.83±2.17</td>
</tr>
<tr>
<td>Normal control</td>
<td>50</td>
<td>1.24±0.18</td>
<td>26.17±3.04</td>
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<tr>
<td>T value</td>
<td></td>
<td>5.82</td>
<td>10.82</td>
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<tr>
<td>$P$ value</td>
<td></td>
<td>&lt;0.05</td>
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</table>

Table 1.

Serum vitamin A and microelement Fe contents (μmol/L).

3.2 Serum VitA content and inflammatory factors

Comparison of serum inflammatory factors IL-6 (pg/mL), PCT (μg/L), sTREM-1 (ng/L) and CRP (mg/L) contents among three groups of subjects was as follows: differences in serum IL-6, PCT, sTREM-1 and CRP contents were statistically significant among three groups of subjects ($P$<0.05); serum IL-6, PCT, sTREM-1 and CRP contents of low VitA group and high VitA group were higher than those of normal control group, serum IL-6, PCT, sTREM-1 and CRP contents of low VitA group were higher than those of high VitA group, and differences in pair-wise comparison of serum IL-6, PCT, sTREM-1 and CRP contents were statistically significant among groups ($P$<0.05), shown in Table 2.

Table 2.

Relationship between serum VitA content and inflammatory factors.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>IL-6</th>
<th>PCT</th>
<th>sTREM-1</th>
<th>CRP</th>
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</thead>
<tbody>
<tr>
<td>Low VitA group</td>
<td>39</td>
<td>38.49±4.51*</td>
<td>15.38±1.94*</td>
<td>73.28±9.14*</td>
<td>182.93±25.47*</td>
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<td>High VitA group</td>
<td>39</td>
<td>22.17±2.95*</td>
<td>8.15±0.97*</td>
<td>30.72±4.51*</td>
<td>113.72±14.62*</td>
</tr>
<tr>
<td>Normal control</td>
<td>50</td>
<td>6.03±0.79</td>
<td>2.08±0.31</td>
<td>7.34±0.84</td>
<td>20.18±3.42</td>
</tr>
<tr>
<td>T value</td>
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<td>12.91</td>
<td>9.43</td>
<td>15.83</td>
<td>19.23</td>
</tr>
<tr>
<td>$P$ value</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Note: compared with control group, *$P$<0.05; compared with high VitA group, †$P$<0.05.

3.3 Serum VitA content and immune response

Comparison of serum humoral immunity indexes IgG, IgA and IgM contents among three groups of subjects was as follows: differences
in serum IgG, IgA and IgM contents were statistically significant among three groups of subjects \((P<0.05)\); serum IgG, IgA and IgM contents of low VitA group and high VitA group were higher than those of normal control group, serum IgG, IgA and IgM contents of low Fe group were higher than those of high Fe group, and differences in pair-wise comparison of serum IgG, IgA and IgM contents of low Fe group and high Fe group were higher than those of normal control group, showing that there are VitA and Fe deficiency in children with pneumonia and normal children, and it was found that serum VitA and Fe contents of observation group were lower than those of normal control group, showing that there are VitA and Fe deficiency in children with pneumonia, but the correlation between specific deficiency degree and the illness is to be confirmed in following study.

Local and systemic inflammatory response in the lung are the main pathological symptoms of pediatric pneumonia, a large number of pathogens can induce the release of CRP and other sensitive inflammatory factors, the massively produced CRP further encourages the synthesis and secretion of IL-6, PCT and other pro-inflammatory factors, and the two interact with each other and form the inflammatory cascade reaction. \([10,11]\). STREM-1 is the receptor protein mainly expressed on the surface of neutrophils and DNA synthesis, and Fe deficiency can restrain the existing DNA synthesis, and Fe deficiency can restrain the existing chain of red blood cells, and can also affect periodic lymphocyte hemoglobin molecules, is directly related to the role of respiratory tract and gastrointestinal tract infection. \([5,6]\). The study of JIANG Yi-Ling\([7]\) shows that VitA deficiency has certain correlation with childhood pneumonia, and as the VitA levels decrease, the risk of pneumonia increases. Fe is an important component of respiratory chain of red blood cells, and can also affect periodic lymphocyte DNA synthesis, and Fe deficiency can restrain the existing lymphocyte activity and affect the normal immune function. \([8,9]\).

In the study, serum VitA and Fe contents were compared between children with pneumonia and normal children, and it was found that serum VitA and Fe contents of observation group were lower than those of normal control group, showing that there are VitA and Fe deficiency in children with pneumonia, but the correlation between specific deficiency degree and the illness is to be confirmed in following study.

### 3.4 Serum Fe content and inflammatory factors

Comparison of serum inflammatory factors IL-6 (pg/mL), PCT (μg/L), sTREM-1 (ng/L) and CRP (mg/L) contents among three groups of subjects was as follows: differences in serum IL-6, PCT, sTREM-1 and CRP contents were statistically significant among three groups of subjects \((P<0.05)\); serum IL-6, PCT, sTREM-1 and CRP contents of low Fe group and high Fe group were higher than those of normal control group, serum IL-6, PCT, sTREM-1 and CRP contents of low Fe group were higher than those of high Fe group, and differences in pair-wise comparison of serum IL-6, PCT, sTREM-1 and CRP contents were statistically significant among groups \((P<0.05)\), shown in Table 4.

### 3.5 Serum Fe content and immune response

Comparison of serum humoral immunity indexes IgG, IgA and IgM contents among three groups of subjects was as follows: differences in serum IgG, IgA and IgM contents were statistically significant among three groups of subjects \((P<0.05)\); serum IgG, IgA and IgM contents of low Fe group and high Fe group were higher than those of normal control group, serum IgG, IgA and IgM contents of low Fe group were higher than those of high Fe group, and differences in pair-wise comparison of serum IgG, IgA and IgM contents were statistically significant among groups \((P<0.05)\), shown in Table 5.

### 4. Discussion

VitA is the bioactive \(\beta\)-ionone derivative, its effective ingredient retinoic acid is involved in epithelial cell differentiation, immune regulation, organ development and maturation as well as multiple other physiological processes, and it is closely related to the respiratory tract and gastrointestinal tract infection. \([5,6]\). The study of JIANG Yi-Ling\([7]\) shows that VitA deficiency has certain correlation with childhood pneumonia, and as the VitA levels decrease, the risk of pneumonia increases. Fe is an important component of the respiratory chain of red blood cells, and can also affect periodic lymphocyte DNA synthesis, and Fe deficiency can restrain the existing lymphocyte activity and affect the normal immune function. \([8,9]\). In the study, serum VitA and Fe contents were compared between children with pneumonia and normal children, and it was found that serum VitA and Fe contents of observation group were lower than those of normal control group, showing that there are VitA and Fe deficiency in children with pneumonia, but the correlation between specific deficiency degree and the illness is to be confirmed in following study.
macrophages, sTREM-1 is combined with transmembrane protein DAPI2 to activate downstream signaling pathways and lead to increased release of inflammatory mediators when infectious disease occurs, it plays an important role in the process of inflammatory response amplification, and it is also considered as the new pro-inflammatory factor[12,13]. In the study, serum inflammatory factor contents were compared between pneumonia children with different VitA and Fe levels, and it was found that serum IL-6, PCT, sTREM-1 and CRP levels of observation group were higher than those of normal control group, serum IL-6, PCT, sTREM-1 and CRP levels of low VitA group were higher than those of high VitA group, and serum IL-6, PCT, sTREM-1 and CRP levels of low Fe group were higher than those of high Fe group. It explains that there is a high inflammation state in children with pneumonia, lower VitA and Fe contents can directly lead to the increase of pro-inflammatory mediator release and the aggravation of inflammatory reaction, and it confirms that VitA and Fe contents in children with pneumonia are negatively correlated with the degree of inflammatory response.

The humoral immune response play an important role in the occurrence and development of pediatric pneumonia, specific IgM antibody appears within 1 week after pathogen infection, IgG antibody content gradually increases2 weeks after infection, and the severer the condition, the higher the IgG content[14,15]. IgA is the antibody in local mucosa for anti-infection immunity, and the serum IgA level increases within 1-2 weeks after infection[16]. The study of SONG Peiguang[17] shows that the humoral immunity indexes IgM, IgG and IgA contents in patients with pneumoniedema are significantly higher than those in healthy people, and there are internal relations between Ig number and the degree of the inflammatory response. In the study, serum humoral immunity index levels were compared between pneumonia children with different levels of VitA and Fe, and it was found that serum IgG, IgA and IgM contents of observation group were higher than those of normal control group, serum IgG, IgA and IgM contents of low VitA group were higher than those of high VitA group, and serum IgG, IgA and IgM contents of low Fe group were higher than those of high Fe group. It shows that there is strong humoral immune response in children with pneumonia, lower VitA and Fe contents can directly lead to the increase of IgG, IgA and IgM contents and the aggravation of humoral immune response, and it confirms that VitA and Fe contents in children with pneumonia are negatively correlated with the degree of humoral immune response.

Serum VitA and Fe contents in children with pneumonia are lower than those in healthy children, and the continuously decreased VitA and Fe can further worsen the systemic inflammatory response and humoral immune response, and lead to further damage. Early detection of serum VitA and Fe contents can be the reliable way for the preliminary diagnosis of pneumonia as well as the evaluation of disease severity and prognosis, and the active VitA and Fe supplementation can be the effective means to prevent infantile pneumonia.

References